PATENT SPECIFICATION

947,060

947,060

Date of Application and filing Complete Specification: April 27, 1960. *No. 14817/60*

Application made in Switzerland (No. 72,784) on April 30, 1959.

Complete Specification Published: January 22, 1964.

Index at Acceptance:—F1 A (4M, 4V, 14B1D, 14D1); F2 T37C.

International Classification:—F 05 b (F 06 j).

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements in Hydraulic Pumps or Motors

I. HANS THOMA, a German Citizen formerly of Rotfluhstrasse 10. Zollikon, Zurich, Switzerland, now of Bellevueweg, 25, Zug, Switzerland, do hereby declare the invention for which I pray that a Patent may be granted to me and the method by which it is to be performed to be particularly described in and by the following statement:

This invention relates to hydraulic pumps or motors of the high speed reciprocating ram or piston type.

The drive or transmission means in such pumps or motors usually includes a crank or its equivalent such as an eccentric, an inclined plate cam or a swashplate. In consequence, when they are under load a considerable side thrust is exerted on each ram or piston, first against one side and then against the opposite side alternately. This results in friction and wear, and at high speeds the creation of excessive heat.

The object of the present invention is to enable the side thrust on the piston to be resisted by bodies of liquid between each piston and its cylinder bore on opposite sides thereof in alternation in such manner that lateral displacement of the piston towards the cylinder wall will act automatically to raise the pressure of the liquid in said bodies of liquid on the side opposing the thrust thereby to resist said lateral displacement and to enable the pressure of the liquid in the bodies of liquid on the opposite side of the piston to fall.

Broadly the present invention consists in a hydraulic pump or motor of the kind specified having means for resisting the lateral displacement of each piston due to side thrust on opposite sides in alternation, said means comprising a series of narrow longitudinally extending and circumferentially separated grooves in either the piston or its cylinder bore nearer the outer than the inner end of its sliding surface, each said groove being capable of retaining a body of liquid and permitting its pressure to rise rapidly and automatically on one side of the piston to resist lateral displacement of the piston due to side thrust and to fall simultaneously in the grooves on the opposite side of the piston, in combination with means for conveying pressure liquid to each of said grooves comprising one or more passages through which pressure liquid can flow freely to the grooves.

In one embodiment of a pump or motor according to the present invention the grooves are in the form of longitudinal and narrow grooves in either the surface of the piston or its cylinder bore, said narrow grooves being open at their inner ends to the pressure liquid and closed at their opposite ends.

To enable the invention to be clearly understood and put into practice several examples of pistons and cylinders suitable for providing the required liquid body thrust resisting areas will now be described by the aid of the accompanying drawings in which:

Fig. 1 is a longitudinal section through a cylinder bore of a hydraulic pump or motor according to one embodiment of the present invention and containing a ram or piston, shown in elevation having two sets of longitudinal grooves, one set being nearer the outer than the inner end of the piston and the other set being nearer the opposite end of the piston.

Fig. 2 is a longitudinal section through a cylinder and piston constituting a slightly modified edition of the embodiment shown in fig. 1.

Fig. 3 is a longitudinal section through one of the cylinder bores with the piston removed showing a manner in which the longitudinal grooves and their supply

passages may be formed in the wall of the cylinder bore and illustrating a means of utilising gravity to prevent or hinder impurities from entering the longitudinal grooves.

Fig. 4 is a cross section through fig. 3 on the line VI-VI.

In all the embodiments illustrated in the drawings the outer ends of the pistons are subjected to a transverse load applied in each direction alternately, one such direction being indicated by the arrow 9 in fig. 1. This load is imposed on each piston 1 by an inclined swashplate or its equivalent not shown acting through the universal joint formed by a ball end 5 on the piston and a slipper 6 that on one side engages the said ball end and on the opposite side the plane face of the swashplate.

In a hydraulic pump or motor according to the embodiments illustrated the above transverse load or side thrust is resisted by opposing bodies of liquid between each ram and its cylinder bore near the outer end of said bore. Similar bodies of liquid are also maintained near the inner end of said bore to resist a torque load acting in an opposite direction to the load which is resisted by the first mentioned bodies of liquid.

In the embodiment illustrated in fig. 1 of the drawings bodies of liquid as above to resist oppositely acting side thrusts are capable of being maintained and for this purpose the ram denoted generally by the reference numeral 1 has two sets of narrow longitudinally extending grooves indicated respectively 7 and 8. each set forming a series of parallel grooves suitably spaced around the circumference of the ram. Each of these grooves acts to retain a small body of pressure liquid.

The grooves 7 near the inner end of the piston are open at their inner ends to the space between the inner end of the piston and the inner end of its cylinder so as to receive liquid from said space when the same is under pressure either during the discharge stroke of the piston in the case of a pump or when the same receives pressure liquid in the case of a motor.

The other set of grooves 8 near the outer end of the piston also receive liquid under pressure from said space individually through separate radial holes 12 opening out of a common supply passage 12^a extending axially through the centre of the piston. See fig. 2. Both the radial holes 12 and the axial passage 12^a permit the pressure liquid to flow freely from the aforesaid space to the respective grooves.

In this embodiment the two sets of grooves 7 and 8 are separated from each other by a circumferential groove 2 and the annulus formed by said groove and the surrounding cylinder wall may be maintained at a reduced pressure by connecting the same to the atmosphere through means comprising an outlet 13.

In the embodiment illustrated in fig. 2 the reduced portion 2 is dispensed with and the outlet 13 connects the exterior of an intermediate full diameter portion to atmosphere through an annular recess surrounding a bush 15 within the piston and an outlet passage 16 leading to atmosphere at the outer exposed end of the piston. In this embodiment the axial passage 12^a extends through the bush 15.

In operation lateral displacement of the ram under the side thrust towards the cylinder wall acts automatically to raise the pressure of the small bodies of liquid held within the grooves in the area opposing the thrust. thereby to resist said lateral displacement and hold the surface of the ram out of metal to metal contact wih the bore. At the same time the pressure of the liquid held in the grooves on the opposite side of the ram will correspondingly fall.

The rise and fall in the pressure of each body of liquid will alternate from one side of the ram to the other in opposition to the alternating change in direction of the thrust.

A similar increase in pressure in the bodies of liquid nearer the inner end of the ram will take place simultaneously with but oppositely to the rise and fall in pressure of the liquid within the grooves at the other or outer end of the ram, to resist lateral displacement of the inner portion 3 of the ram resulting from lateral displacement in the opposite direction of the outer portion 4 of the ram.

Fig. 3 illustrates an embodiment in which the cylinder block rotates and in which both sets of longitudinal grooves 7 and 8 are fed with pressure liquid directly from the recess at the inner end of the ram by means of a main conduit which is so disposed in relation to the axis of the cylinder block that the entry of impurities with the liquid at the inlet end is hindered or prevented by centrifugal force. In the example illustrated and now to be described the liquid passages including the longitudinal grooves are shown as being made in the surface of the cylinder bore, but in practice the longitudinal grooves may be cut, as in the other examples, in the surface of the ram for ease of manufacture.

In the particular construction illustrated in figs. 3 and 4 each cylinder bore is arranged axially in a rotatable cylinder block 20 around the turning axis 33 of the block and each such bore is formed interiorly with three circumferential grooves 31, 28 and 21. The two outer grooves 31 and 21 are fed with pressure fluid from the port 23 by means of a duct 22 and branch passages 31 and 24 respectively.

In the example shown the duct 22 is on

the side of the bore nearest to the axis 33 to which it inclines in the direction of the outer end of each cylinder bore so that the inner end of the duct 22 is furthest away from the axis 33. This ensures that any solid particles in the liquid at the entrance to the duct are subjected to gravity to an extent sufficient to hinder or prevent said solid particles from entering the duct, or discharging those which may have entered, by causing the same to be flung radially outwards away from the duct.

The intermediate groove 28 is connected to the exterior of the cylinder block 20 by a vent 29 so that the interior of said groove is maintained at a pressure which is lower than the pressure obtaining within the outer grooves 31 and 21.

The outer grooves 31 and 21 serve to feed pressure liquid through the open ends of two sets of narrow longitudinal grooves, corresponding to the grooves 7 and 8 in the other examples. In the present example these grooves are shown as being formed in the wall of the bore 32 but as the forming of these grooves especially the inner grooves 7 is difficult, these may be formed, as formerly, in the surface of the ram, which in other respects may have a smooth surface.

WHAT I CLAIM IS :—

1. A hydraulic pump or motor of the kind specified having means for resisting the lateral displacement of each piston due to side thrust on opposite sides in alternation, said means comprising a series of narrow longitudinally extending and circumferentially separated grooves in either the piston or its cylinder bore nearer the outer than the inner end of its sliding surface, each said groove being capable of retaining a body of liquid and permitting its pressure to rise rapidly and automatically on one side of the piston to resist lateral displacement of the piston due to side thrust and to fall simultaneously in the grooves on the opposite side of the piston, in combination with means for conveying pressure liquid to each of said grooves comprising one or more passages through which pressure liquid can flow freely to the grooves.

2. A hydraulic pump or motor according to claim 1 in which the grooves are supplied with pressure liquid from the space between the inner end of their piston and its cylinder.

3. A hydraulic pump or motor according to claim 1 or claim 2 which includes a further set of grooves for each piston which are nearer to the inner than the outer end of the piston and act oppositely to the first set of grooves nearer the outer end of the piston sliding surface.

4. A hydraulic pump or motor according to any of the preceding claims in which each groove is closed at its outer end and open at or near its other end to a pressure liquid supply passage.

5. A hydraulic pump or motor according to claim 4 wherein each groove is individually served with pressure liquid through separate branch passages opening into a main passage extending axially through the piston.

6. A hydraulic pump or motor according to claim 4 wherein the grooves in each piston are open collectively to a circumferential groove in the cylinder wall which in turn is supplied with pressure liquid by one or more unrestricted passages.

7. A hydraulic pump or motor having its rams or pistons and/or cylinders constructed to provide means whereby lateral load on the ram or piston may be resisted according to any of the examples herein described and illustrated in the accompanying drawings.

C. LOCKETT HUGHES,
Chartered Patent Agent,
For the Applicant.

Berwick-upon-Tweed: Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd.—1964
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2. from which copies may be obtained.

947,060 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

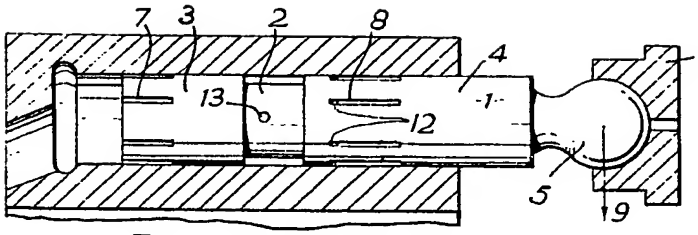

Fig. 1.

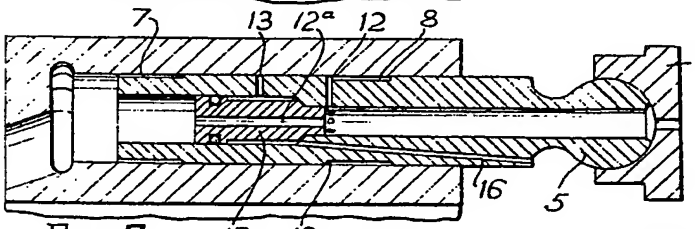

Fig 2

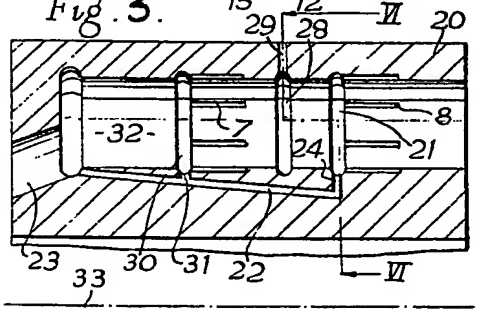

Fig. 3.

Fig. 4.